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IN THE CLAIMS

1-7. Cancelled

8. (New) A heterodyne laser interferometer, comprising:

a heterogeneous mode helium-neon laser light source for generating a light beam having two frequency components that are linearly polarized and perpendicular to one another;

an optical interferometer coupled to receive a first portion of the light beam from the laser light source and to generate a measured signal;

a frequency converter coupled to receive the measured signal and a reference signal that is based on the remaining portion of the light beam, said frequency converter configured to adjust the frequencies of the measured signal and the reference signal without adjusting their relative phase; and

a superheterodyne phase measurer coupled to the frequency converter for measuring a phase of the frequency converted measured signal and the frequency converted reference signal.

9. (New) The heterodyne laser interferometer as claimed in claim 8 further comprising:

a polarizer coupled to receive said remaining portion of the light beam, the polarizer having a polarization axis that is titled at 45° relative to the two frequency components of the light beam;

a photodetector coupled to receive light from the polarizer and in response thereto generate an electrical reference signal represented by

$$V_r = A\cos[2\pi(f_1 - f_2)t]$$

where V_r is the electrical reference signal, A is the amplitude of the electrical reference signal, and f_1 and f_2 are frequency components included in the light beam.

10. (New) The heterodyne laser interferometer as claimed in claim 8 wherein the optical interferometer comprises:

a polarization splitter for splitting the light beam into a first of the two frequency components and a second of the two frequency components;

a fixed reflecting mirror for receiving the first frequency component;

a movable reflecting mirror for receiving the second frequency component;

a polarization combiner for combining the first frequency component reflected by the fixed reflecting mirror with the second frequency component reflected by the movable reflecting mirror, said polarization combiner having a polarization axis that is titled at 45° relative to the two frequency components of the light beam; and

a photodetector for receiving combined light from the polarization combiner and in response generating the measured signal as an electrical signal, wherein the electrical signal is represented by

$$V_m = B\cos\{2\pi(f_1 - f_2)t + 2nd_1 / \lambda_1 - 2nd_2 / \lambda_2\}$$

where V_m is the measured signal, B is the amplitude of the signal, λ_1 and λ_2 are wavelengths of the light having the first and second frequency components, respectively, d_1 is a distance that the first frequency component has traveled in air, d_2 is a distance that the second frequency component has traveled in air, and n is the refractive index of air.

11. (New) The heterodyne laser interferometer as claimed in claim 8, wherein the frequency converter comprises:

a local oscillator for generating a local signal approximately equal to a beat frequency of the reference signal;

a signal splitter for splitting the local signal into first and second local signals;

first and second mixers for multiplying the reference signal with the first and second local signals respectively to provide first and second output signals, respectively;

a first filter for eliminating from the first output signal a signal corresponding to the sum of the reference signal and the first local signal;

a second filter for eliminating from the second output signal a signal corresponding to the sum of the reference signal and the second local signal, whereby the phase measurer receives third and fourth signals passing through the first and second filters, respectively.

12. (New) The heterodyne laser interferometer as claimed in claim 11, wherein the third signal is represented by

$V_m' = A\cos 2\pi ft$

and the fourth signal is represented by

$V_m' = B\cos\{2\pi(ft + 2nd_1/\lambda_1 - 2nd_2/\lambda_2\}$

where $f = f_1 - f_2 - f_{LO}$, f_{LO} is the frequency of a local oscillation signal, f_1 and f_2 are the first and second frequency components, respectively, λ_1 and λ_2 are wavelengths of the light having the first and second frequency components, respectively, d_1 is a distance that the first frequency component has traveled in air, d_2 is a distance that the second frequency component has traveled in air, and n is the refractive index of air.

13. (New) The heterodyne laser interferometer as claimed in claim 10, further comprising:

a signal splitter for splitting the measured electrical signal into first and second split signals;

a first mixer for multiplying the first split signal by a local oscillation signal having a frequency f_b+f to produce a third signal;

a second mixer for multiplying the second split signal by a local oscillation signal having a frequency f_b-f to produce a fourth signal;

a first filter for eliminating radio frequency components from the third signal to generate a fifth signal having a frequency $f + \Delta f$;

a second filter for eliminating radio frequency components from the fourth signal to generate a sixth signal having a frequency $f - \Delta f$; and

wherein the phase measurer is configured to use the fifth signal when a Doppler frequency is positive and the sixth signal when the Doppler frequency is negative.

14. (New) A heterodyne laser interferometer, comprising:

a heterogeneous mode helium-neon laser light source for generating a light beam having two frequency components that are linearly polarized and perpendicular to one another;

an optical interferometer coupled to receive a first portion of the light beam from the laser light source and to generate a measured signal;

a frequency converter coupled to receive the measured signal and a reference signal that is based on the remaining portion of the light beam, said frequency converter configured to adjust the frequencies of the measured signal and the reference signal without adjusting their relative phase; and

a superheterodyne phase measurer coupled to the frequency converter for measuring a phase of the frequency converted measured signal and the frequency converted reference signal;

a polarizer coupled to receive said remaining portion of the light beam, the polarizer having a polarization axis that is titled at 45° relative to the two frequency components of the light beam;

a photodetector coupled to receive light from the polarizer and in response thereto generate an electrical reference signal;

wherein the optical interferometer comprises:

a polarization splitter for splitting the light beam into a first of the two frequency components and a second of the two frequency components;

a fixed reflecting mirror for receiving the first frequency component;

a movable reflecting mirror for receiving the second frequency component;

a polarization combiner for combining the first frequency component reflected by the fixed reflecting mirror with the second frequency component reflected by the movable reflecting mirror, said polarization combiner having a polarization axis that is titled at 45° relative to the two frequency components of the light beam; and

a photodetector for receiving combined light from the polarization combiner and in response generating the measured signal as an electrical signal;

wherein the frequency converter comprises:

a local oscillator for generating a local signal approximately equal to a beat frequency of the reference signal;

a signal splitter for splitting the local signal into first and second local signals;

first and second mixers for multiplying the reference signal with the first and second local signals respectively to provide first and second output signals, respectively;

a first filter for eliminating from the first output signal a signal corresponding to the sum of the reference signal and the first local signal;

a second filter for eliminating from the second output signal a signal corresponding to the sum of the reference signal and the second local signal, whereby the phase measurer receives third and fourth signals passing through the first and second filters, respectively.